REMARKS

Summary of Amendments

Claim 8 has been amended to correct the error in dependency.

Further, added are the following new claims: claim 17, corresponding in subject matter to claims 1 and 3; claim 18, corresponding in subject matter to claims 1, 2 and 3; claim 19, corresponding in subject matter to claims 5 and 9; and claim 20, corresponding in subject matter to claims 5, 7 and 9.

Claim Rejections - 35 U.S.C. § 112

Claim 8 was rejected for indefiniteness in that claim 8 was recited as depending from claim 8—that is, from itself—and in turn, claim 16 was rejected as depending from a rejected claim 8.

Claim 8 has been amended to depend from claim 5; according claim 16 now depends from a properly recited dependent claim 8.

Claim Rejections - 35 U.S.C. § 102

Claims 1-4, 8, 10-12 and 16; Rolander et al. '909

Claims 1-4, 8, 10-12 and 16 stand rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Pat. No. 6,007,909 to Rolander et al.

Under this section, the Office action alleges that the Rolander et al. patent discloses "the claimed coating with the claimed thickness and stress . . . on the claimed tool containing tungsten carbide and the claimed proportion of cobalt." Applicants respectfully beg to differ because:

(1) The subject matter of the present invention, as recited in claim 1 as filed, is a coated, tungsten-based *cemented carbide* machining tool. Rolander et al. is directed to CVD-coated, sintered titanium-based *carbonitrides*, or cermets. The cutting-tool inserts as disclosed by Rolander et al. are made "of a carbonitride alloy with titanium as main component," as stated in the first paragraph of the Background section of their patent; moreover, claim 1 therein recites "A cutting tool insert of titanium-based carbonitride."

Indeed, in the background section of their patent—from column 1, line 15 to column 2, line 20—Rolander et al. discuss in detail *drawbacks* to coated WC-Co based alloys. Yet WC-Co based alloys are, as noted above, precisely the subject matter of the present invention. Then from line 21 in column 2, to the end of the background section, Rolander et al. explain why their invention is directed instead to titanium-based carbonitride alloys.

In particular, in the second paragraph of the background section of the '909 patent, Rolander et al. discuss CVD coatings onto alloys of tungsten carbide and cobalt, where they note that with CVD-coated WC–Co alloys, because the CVD process requires "relatively high deposition temperatures," and because the WC–Co alloys have a smaller thermal expansion coefficient than the coatings, the coatings contract more than the WC–Co base material, leading to cracks in the coatings.

Rolander et al. point out that one way to address this problem is to employ "low temperature coating processes such as physical chemical vapour deposition (PVD)" (column 1, lines 56 and 57). Another approach—and the one taken by Rolander et al.—is to employ, as the base material of a cutting tool insert, "[t]itanium-based carbonitride alloys, so-called cermets" (column 2, line 21), which "are harder and chemically more stable than WC–Co based hard materials, but unfortunately also considerably more brittle" (column 2, lines 59-61). This approach allows the thermal expansion coefficient of the base material to be matched with that of the coating. Actually, the Rolander et al. technique is to have the thermal expansion coefficient of the cermet alloy be "moderately higher than that of the coating materials" (column 4, lines 18 and 19).

Then, at column 5, lines 39-45, Rolander et al. describe that in order to have the thermal expansion coefficient of their base-material cermet thus be higher than that of the coating, nitrogen must be present in the cermet:

> Generally, in cermet alloys an increase in N and/or binder phase content will increase the thermal expansion coefficient whereas an increase in W content will decrease it. If Ti in the cermet alloy is partly replaced by other elements commonly used in cermet alloys, e.g., Ta, Nb, V, Hf, Zr, Mo, Cr, this will also result in a decrease in the thermal expansion coefficient.

(2) Although the proportion of cobalt that the Office action cites from the Rolander et al. disclosure overlaps the claimed range in the present application, that proportion is in a cermet that "consists of C, N, Ti, W and Co" (claim 6 of Rolander et al., which the Office action mentions), and as just discussed, N is a critical component of the base material of Rolander et al.

In contrast, the base material of the surface-coated machining tool of the present invention does not contain nitrogen, and nowhere does the specification in the present application teach or suggest that the base material could or should contain nitrogen.

(3) Rolander et al. do disclose a coating thickness of 1-20 μm. Further, Rolander et al. suggest a compressive residual stress of 0-1000 MPa (for example, at column 3, line 65)—that is, 0 to 1 GPa. The compressive residual stress imparted to the thin-film coating in the present invention is 0.1 to 8 GPa, while the thickness of the compound thin film on the surface-coated machining tool claimed in the present application is 0.05 to 3 μm.

Nevertheless, it is respectfully submitted that despite overlap in these ranges, such overlap is for the foregoing reasons a moot point, since Rolander et al. is directed to CVD-coated, sintered titanium-based cermets, whereas the present invention is a coated, tungsten-based cemented carbide machining tool.

And it is notable that at column 4, lines 58-62, Rolander et al. state:

> It is our belief that the average compressive stress of the layer or layers with a thickness > 1 μm in the coating at room temperature shall be in the range more than zero and up to 1000 MPa, preferably 100-800 MPa, most preferably 200-500 MPa. However, the optimum stress must be determined experimentally for each cutting application area.

Moreover, claim 1 of Rolander et al. recites a compressive residual stress of 100-800 MPa. This would beg the question of whether stress outside this range would yield a workable tool according to the Rolander et al. technology.

For the foregoing reasons it is respectfully submitted that claim 1 should be held allowable over Rolander et al., and that dependent claims 2-4 and 10-12 should in turn be held allowable as depending from an allowable base claim. Claim 8 as amended now depends from claim 5, which was not rejected under this section of the Office action. As claim 16 depends from claim 8, the rejection of that claim under this section should no longer apply.

New claims 17 and 18 recite (as does claim 5) that the base material is coated "by a physical vapor deposition method," as discussed in paragraphs [0029] and [0030] of the present specification. Accordingly, in contrast to the Rolander et al. approach as discussed at (1) above, the present invention as set forth in these claims involves PVD-coated WC–Co alloys, which Rolander et al. actually teach away from (column 1, lines 55-60):

> The problem of crack formation can to a certain extent be solved by employing low temperature coating processes such as physical vapour deposition (PVD), plasma assisted CVD or similar techniques. However, coatings produced by these techniques generally have inferior wear properties, lower adhesion and lower cohesiveness.

Claim Rejections - 35 U.S.C. § 103

Claims 5-7, 9 and 13-15; Cutler '102 in view of Oskarsson '139

Claims 5-7, 9 and 13-15 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Pat. No. 5,952,102 to Cutler in view of U.S. Pat. No. 6,228,139 to Oskarsson.

Under this section, the Office action appears to allege a motivation to combine the teachings of Cutler with those of Oskarsson "to provide on the substrate of Oskarsson the claimed diamond coating of Cutler," in that doing so "would have been obvious to one of ordinary skill in the art." Nevertheless, the Office action offers no evidentiary arguments to suggest that the Cutler-Oskarsson combination would be workable.

The citation of the Cutler patent suggests that the claim 5 recitation of "a hard carbon thin film made up essentially of carbon atoms only" is being read as equivalent to a diamond layer—perhaps because the present specification describes, in paragraph [0028], that a physical vapor deposition method making graphite the starting material is utilized to produce "a structure closer to a diamond structure than are so-called hydrogen-containing hard carbon thin films."

Claim 5 recites "a hard carbon thin film" coated by PVD onto "a cemented-carbide base material containing tungsten carbide and cobalt."

Yet Cutler teaches *away* from diamond coatings on WC–Co alloys: Lines 31-34 in column 1 of Cutler state, "It is known that cobalt interferes with adhesion of [diamond coatings onto] WC–Co inserts and many techniques have been devised to try and improve the adhesion of diamond to cemented carbides."

More specifically, claim 5 recites: "a cemented-carbide base material containing tungsten carbide and cobalt, with the cobalt inclusion amount being 4 weight % or more and 12 weight % or less." And yet Cutler states (column 1, lines -61):

> Tungsten carbide 6 wt. % Co substrates have a coefficient of thermal expansion of $\approx 5 \times 10^{-6}/°C$ and can therefore be used to put the

> diamond coating in compression. Unfortunately, the poor adhesion at the interface limits these coatings thicknesses, such that either it is impractical to deposit thick coatings due to slow deposition rates or the coatings spall off due to the high residual stresses at the weakly bonded interfaces.

That is, while claim 5 of the present application sets forth a base material containing tungsten carbide and 4-12 wt. % included cobalt, Cutler as quoted above clearly teaches away from tungsten carbide substrates containing 6 weight % cobalt. Instead, Cutler is directed to producing substrates coated with relatively thick diamond layers, and teaches a base material that is "binderless WC . . . which ha[s] improved adhesion compared with WC–Co substrates or modified WC–Co substrates" (column 3, lines 42-44).

In the paragraph that begins in line 6 of column 4, Cutler, focusing on improving the adhesion of the diamond coating to the tool, teaches a coarse-grained WC substrate, explaining that the higher surface roughness of coarse-grained WC provides for increased mechanical interlocking of the diamond coating to the substrate. In the same passage, Cutler also teaches that the absence of Co from the substrate means there is "no metallic catalyst to aid in the conversion of diamond to graphite (which results in weak bonding)."

The advantages to the absence of Co from the tool substrate of Cutler are explained further, at column 4, lines 52-55 of the Cutler patent: "While removing Co from WC–Co materials lowers toughness, it has the positive advantage of limiting catalysis of the diamond-to-graphite reaction and lowers the thermal expansion mismatch between the CVD diamond and the substrate." And at column 7, lines 25-30, Cutler reiterates:

> The important point is that when diamond or diamond-like materials are deposited on WC or materials similar to WC they adhere much better than they do to WC–Co or other such materials which have metals present such that they promote the back-conversion of diamond to graphite.

In the column-4 paragraph mentioned earlier, Cutler, referring to Figs. 1 and 2 therein, explains that his preferred coarser-grained WC substrate is also tougher, but the tradeoff is a loss in hardness with the coarser (tougher) substrate. Finally, Cutler teaches that while the advantages to finer-grained, "submicron WC" are that it can be diamond coated because the absence of cobalt prevents the "back conversion of diamond to graphite, . . . the fine grain size limits mechanical interlocking" of the diamond coating to the substrate.

In sum, Cutler teaches, for diamond-coated tools, WC substrates that are absent Co so as to prevent back-conversion of diamond to graphite, and are coarser-grained so as to compensate for the loss of toughness due to the absence of Co.

Cutler's preferred grain size is "of the order of 2-5 μm." (column 4, lines 41 and 42), while pre-sintering crystal-grain size as claimed in the present invention is between 0.1 μm and 1.5 μm.

The loss of hardness as a consequence of greater toughness in the WC taught by Cutler appears to be compensated by Cutler's preferred thicker diamond coatings:

> One desires a very strong substrate, similar in strength to that of WC–Co. Because WC has lower strength than WC–Co, surface compressive stresses are used to superimpose a compressive stress near the outside of the component in order to counteract the applied tensile stress. Thicker diamond coatings result in lower compressive stress in the coating, but also result in superimposed compressive stresses over a larger region of the tool

(column 5, lines 32-39). Thus Cutler teaches primarily toward diamond coating thickness greater than 30 μm; in contrast, the hard carbon thin film claimed in the present invention is 0.05 μm or more, and 3 μm or less in thickness.

Meanwhile, Oskarsson teaches alloying a grain-growth inhibitor with Co to enable finer grain size in a WC–Co-based cemented carbide (Summary section).

Accordingly, Oskarsson teaches fine grained, WC–Co substrates, which runs counter to what Cutler teaches, in that Cutler expressly teaches the absence of Co, and coarser- rather than finer-grained WC substrates. (Oskarsson gains better toughness in his submicron-grained substrates through the special grain morphology he teaches [column 3, lines 11-13].)

Thus there is no teaching or suggestion in the Cutler reference that would motivate a person skilled in the art to coat the WC–Co cemented carbide of Oskarsson with the diamond coating of Cutler, especially since Cutler teaches away from the substrates taught by Oskarsson. Conversely, there is no teaching in Oskarsson as to diamond coatings in particular, since the focus of Oskarsson is on the substrates—the focus is on producing submicron-grained WC–Co-based cemented carbides for coatings in general, as discussed in the first paragraph of the background section therein.

For the foregoing reasons, it is respectfully submitted that the diamond coatings as taught by Cutler could not, by that very teaching, go onto a substrate as taught by Oskarsson; that a motivation to combine the teachings of these references is thus lacking from either; and therefore that no combination of the teachings of, or suggestions in, these references can be said to render obvious the subject matter of claim 5 and its dependent claims in the present application.

Accordingly, Applicant courteously urges that this application is in condition for allowance. Reconsideration and withdrawal of the rejections is requested. Favorable action by the Examiner at an early date is solicited.

Respectfully submitted,

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